REMARKS

In the Office Action, dated July 9, 2008, the Examiner states that Claims 1-63 are pending, Claims 41-44 are withdrawn and Claims 1-40 and 45-63 are rejected. By the present Amendment, Applicant amends the claims.

Claims 1-7, 11-40 and 45-63 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kametani et al. (US 5,032,176) in view of Murphy et al. (Equilibrium Calculation of the Reduction of Titanium Tetrachloride by Aluminium and Hydrogen, High Temp. Chem. Processes 3, August 1994, pp. 365-374). Claims 8-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kametani et al. in view of Murphy et al. and O'Donnell et al. (US 5,397,375). Applicant respectfully disagrees with and traverses these rejections.

The Office Action asserts that Kametani et al. discloses a method to produce titanium-aluminium compounds comprising a first step of reducing an amount of titanium chloride with an amount of aluminium to trigger reactions at a temperature of 100°C to 900°C to form the products of the first step (which the Office Action contends would inherently be titanium subchloride(s) and $AlCl_3$ when aluminium is used as a reducing agent to reduce $TiCl_4$ as disclosed in Murphy et al.); and then a second step of mixing the products of the first step and heating the mixture in a reaction zone to a temperature above 300°C to form $AlCl_3$ in a gas phase and to produce in the reaction zone the titanium-aluminium compounds.

Applicant respectfully asserts that the Office Action has mischaracterized the methods disclosed in Kametani et al. Applicant respectfully submits that the methods described in Kametani et al. are fundamentally different to the methods of the present invention. Kametani et al. describes methods for manufacturing a titanium powder or a temperature of from 100°C to 900°C to continuously fall into a reaction vessel, and ejecting a titanium tetrachloride gas at a temperature of from 650°C to 900°C towards the falling flow of the molten reducing agent, which results in the production of a molten reaction product and titanium particles containing the molten reaction product though a reducing reaction between the atomized molten reducing agent and the titanium tetrachloride gas. The titanium particles are subsequently separated and processed to obtain the titanium powder. In some embodiments, titanium composite powders may be formed by either adding a second metal (such as aluminium) to the molten reducing agent or by adding a metal

chloride gas (such as aluminium chloride) to the titanium tetrachloride gas.

However, the reducing species in the methods described in Kametani et al. is molten magnesium or molten sodium and not aluminium (see, for example, Reaction (1) at line 67 in column 4, and Reaction (2) at line 31 in column 9, as well as lines 51 to 54 in column 4). Indeed, the "chloride gas of at least one metal selected from the group consisting of aluminium, vanadium, tin, chromium, iron, zirconium and zinc" (see line 61 or column 5) or the "at least one metal to be alloyed with titanium such as aluminium, tin and zinc" (see line 7 in column 12) in Kametani et al. is introduced only for the purpose of providing another metal for incorporation into the resultant titanium composite powder. As aluminium is not used as a reducing agent in Kametani et al., we submit that the methods described in Kametani et al. and the methods of the present invention are fundamentally different.

The Office Action contends that titanium subchloride(s) and $AlCl_3$ would inherently be present as the products of the first step of Kametani et al. when the aluminium is used as a reducing agent to reduce $TiCl_4$ as disclosed by Murphy et al. However, Applicant respectfully asserts that because Al is not the reducing agent in Kametani et al., then titanium subchloride(s) and $AlCl_3$ would <u>not</u> inherently be present as intermediates, regardless of the teachings of Murphy et al.

The invention of the present application includes the feature that step 1 results in the formation of titanium subchloride(s) and aluminium chloride products and, in step 2, the titanium subchlorides be reacted, under a different set of reaction conditions, with aluminium to form a pure final product of titanium-aluminium alloys.

In contrast thereto, Kametani et al. describes that the products of the first step are titanium particles containing a molten reaction product. Step 2 of Kametani et al. does not include any chemicals reactions, but only involves separating the reaction products (e.g. titanium particles), from other reactions products (e.g. magnesium chlorides). The reactions which lead to the formation of products occur in step 1 of Kametani et al., and step 2 is no more than a removal and separation step.

As recited in the present specification, the stepwise process of the present invention can provide a cheaper and more controllable process for the production of titanium-aluminium compounds. It was known in the art that direct reduction of titanium tetrachloride with aluminium in a one-step process results in the formation of an uncontrollable composition of products (see lines 4 to 11 on page 3 of the PCT

specification). These uncontrollable results are curbed by the present invention and thus the importance of a two step reaction process to the present invention further highlights the fundamental differences between Kametani et al. and the present invention.

Murphy et al. describes theoretical calculations for the reduction of titanium chloride with aluminium and hydrogen. These calculations start from an assumption that the constituent components exist in their elemental phases, and then proceeds to determine the appropriate composition corresponding to minimum Gibbs free energy. In this particular case, the calculations start from Al, Ti and Cl in their elemental states and then proceeds to determine what compounds would be formed at various temperatures.

Applicant respectfully asserts that the experimental calculations described in Murphy et al. relate only to gaseous atomic products of Ti, Al and Cl reacting for indefinite times at temperatures in excess of 1500°C. Such conditions cannot be applied to the methods described in Kametani et al., for example, because the reactions in Kametani et al. are limited by Kinetic factors such as the size of the liquid metal particles, short resistance time and the requirement to have a mixture of titanium/molten product base. In contrast, in Murphy et al., kinetic considerations are neglected, and it is assumed that there is an infinite time for the reaction to take place, and also that all species involved (i.e. Ti, AL and Cl) are in intimate contact. As such, if the prior art references were combined as suggested in the Office Action, the intended function of each of the references would be destroyed. Since one of ordinary skill in the art would understand that combining Murphy et al. with Kametani et al. would destroy its intended function, Applicant respectfully asserts that one of ordinary skill in the art would not be motivated to apply the extreme (theoretical) experimental conditions described in Murphy et al. to the methods of Kametani et al.

Indeed, given that Kametani et al. relates to reducing titanium tetrachloride with sodium or magnesium and Murphy et al. relates to reducing titanium tetrachloride with aluminium or hydrogen (which are fundamentally different processes), Applicant respectfully asserts that one of ordinary skill in the art would not consider applying the teachings of Murphy et al. to the methods of Kametani et al.

However, should the Examiner still consider that one of ordinary skill in the art

would be motivated to use aluminium as a reducing agent instead of sodium or magnesium in the methods of Kametani et al. based on the teachings of Murphy et al., Kametani et al. specifies that the reducing agent must be a molten metal. For aluminium to be in a molten state, the temperature must be more than 660°C (see, for example, Example 2 of Kametani et al. where titanium composite powder was manufactured from a molten mixture of magnesium (the reducing agent) and aluminium at about 700°C). In this respect, the article cited on page 3 of the specification for the present application (by Gerdemann and Alman) describes that at temperatures higher than 500°C, reactions between $TiCl_4$ and aluminium occur in a single step, resulting in a loss of control over the products. Indeed, as noted above, it was known in the art that reactions between titanium tetrachloride and aluminium result in the formation of an uncontrollable mixture of products.

Therefore, Applicant respectfully asserts that one of ordinary skill in the art would not be motivated to use aluminium as a reducing agent instead of sodium or magnesium in the methods of Kametani et al., because if molten aluminium were used in the essentially one-step process described in Kametani et al., they would understand that reactions would occur in a one-step process, and would result in the formation of uncontrollable products.

Applicant further asserts that the theoretical experimental conditions described by Murphy et al. cannot possibly be implemented in the apparatus described by Kametani et al. because Murphy et al. requires a temperature in excess of 1400°C in order to produce atomic species, which is much higher than the 900°C described in Kametani et al.

Applicant also respectfully asserts that if magnesium or sodium was replaced with aluminium in the methods described in Kametani et al., the reaction would be $TiCl_4 + 1.33\ Al \rightarrow Ti + 1.33\ AlCl_3$ (see formulae (1) and (2) in columns 1 and 2). At a reaction temperature of between 650°C and 900°C, $AlCl_3$ is gaseous. However, Kametani et al. does not describe any means for handling gaseous products. Furthermore, if $AlCl_3$ gas were produced, it would need to be removed in the gas phase on line. Again, Kametani et al. describes no means for handling such situations. Therefore, Applicant respectfully asserts that even if one of ordinary skill in the art would somehow be motivated to use aluminium as a reducing agent in the methods and apparatus described in Kametani et al., then not only would they

expect that such a reaction would result in the uncontrollable formation of products, the apparatus of Kametani et al. would be completely unsuitable for performing such a reaction, and extensive modification would be required.

For the reasons set out above, Applicant respectfully asserts that independent Claim 1 is not obvious in light of Kametani et al. in view of Murphy et al.

With respect to independent Claims 27, 29, 31 and 33, Kametani et al. does not describe or teach a <u>two step</u>, <u>controllable</u> reaction process for the production of titanium-aluminium compounds or alloys. Indeed, the methods described in Kametani et al. are fundamentally different to the methods defined by claims 27, 29, 31 and 33. Also, Applicant reiterates its earlier submission that one of ordinary skill in the art would not seek to apply the teaching of Murphy et al. to Kametani et al. because of the differences between the methods and apparatus of Kametani et al. and the theoretical experimental conditions described in Murphy et al.

In relation to independent Claims 37 and 39, which are directed to a method for the production of vanadium and/or vanadium compounds and a method for the production of zirconium and/or zirconium compounds respectively, Applicant respectfully asserts that Kametani et al. does not teach or suggest mixing aluminium with a precursor material including vanadium subhalide or zirconium subhalide. Kametani only discloses that the titanium chloride gas to be ejected toward the falling flow of the molten reducing agent may be mixed with aluminium chloride gas and/or vanadium chloride gas and/or zirconium chloride gas. These are completely different reaction conditions to those defined by Claims 37 and 39.

Furthermore, Kametani et al. does not describe a method for producing vanadium and/or a vanadium compound or zirconium and/or a zirconium compound, but only describes producing titanium composite powders, which may contain aluminium and/or vanadium and/or zirconium. For these reasons, in combination with the reasons discussed above, Applicant respectfully asserts that Claims 37 and 39 are not obvious over Kametani et al. in view of Murphy et al.

Since the independent claims are allowable over the prior art, Applicant asserts that all claims depending therefrom are allowable for at least the same reasons, as well as for the features that they recite. As such, Applicant respectfully requests withdrawal of the present rejections under 35 U.S.C. 103(a).

In light of the foregoing response, all the outstanding objections and rejections are considered overcome. Applicant respectfully submits that this application should now be in condition for allowance and respectfully requests favorable consideration.

Respectfully submitted,

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